

EARLY CRETACEOUS BELEMNITES FROM SOUTHERN MOZAMBIQUE

by PETER DOYLE

ABSTRACT. *Neohibolites ewaldi* (v. Strombeck, 1861) and *Peratobelus foersteri* sp. nov. are described from the Upper Aptian sediments of the Rio Maputo river, near Catuane, southern Mozambique. *Peratobelus* has a wider distribution than was first thought, occurring on both Tethyan (Mozambique) and Pacific (Antarctica, Australia) coasts of Gondwana. The presence of *Neohibolites* in Mozambique strengthens the hypothesis of a widespread migration of this genus in the Aptian–Albian.

THE following is a study of fifty-two complete and fragmentary belemnite rostra collected by Drs H. Wachendorf and R. Förster from one stratigraphic section on the Rio Maputo river, near Catuane, southern Mozambique (26° 49' 50" S, 32° 13' 15" E). The stratigraphy of this section has been discussed in detail by Henriques Da Silva (1962: locality B), Wachendorf (1967), and more recently by Förster (1975). The succession exposed there consists of more than 10 m of glauconitic sandstones, marls, and occasional limestones, containing a rich ammonite fauna (including species of *Tropaeum*, *Ammonitoceras*, and *Acanthohoplites*) indicative of an Upper Aptian age (Henriques Da Silva 1962; Wachendorf 1967; Förster 1975). This succession forms part of the transgressive Maputo Formation (Barremian–Turonian) which overlies the Triassic–Jurassic Karroo Volcanics in this region.

The belemnites belong to the genera *Neohibolites* and *Peratobelus*, and were first recognized as such by Wachendorf (1967: discussion by Schmid, p. 279). Previously, there have been only scant references to Cretaceous belemnites from Mozambique, although the rich belemnite fauna of adjacent Madagascar is well known (e.g. Besairie 1930). Newton (1924) referred to a few specimens from Port Amelia, northern Mozambique, and these belong to the early Cretaceous genus *Duvalia* (or *Pseudoduvalia*) (BM.C.25957–25958). Two other belemnite fragments from nearby may be juvenile *Hibolithes*, or even *Neohibolites* (BM.C.25955–25956). Spath (1939) described a new species of diplobelid belemnite from the Upper Aptian of Chalala, southern Mozambique (*Conoteuthis rennieri*) which was later redescribed by Jeletzky (1981) as type of his new diplobelid genus *Chalalabelus*. Bowen (1963) determined an Upper Aptian palaeotemperature of approximately 17° C using belemnites from Manyola Drift, southern Mozambique.

The purpose of this paper is to describe in detail the Rio Maputo belemnites, and discuss their biogeographical significance. Unless otherwise stated, all specimens are housed in the Bayerische Staatssammlung für Paläontologie und historische Geologie, Munich and are prefixed by: 1967 xxvii. The terminology used below is discussed in a separate paper on the Dimitobelidae (Doyle 1987a), and it may also be useful to consult Stevens (1965). Abbreviations are as follows: BM, British Museum (Natural History); L, total preserved length of rostrum; X, length from apex to rostrum to position of maximum inflation; Dvmax, maximum dorsoventral diameter; Dlmax, maximum lateral diameter; Dvl; dorsoventral diameter at position of Dlmax. All measurements in mm.

SYSTEMATIC PALAEOLOGY

Order BELEMNITIDA Zittel, 1895
 Suborder BELEMNOPSEINA Jeletzky, 1965
 Family BELEMNOPSEIDAE Naef, 1922
 Genus NEOHIBOLITES Stolley, 1911

Type species. *Belemnites ewaldi* v. Strombeck, 1861, by subsequent designation of Gorn (1968, p. 383).

Diagnosis. See Stolley (1911a, p. 174), Swinnerton (1955, p. xxxix), Spaeth (1971, p. 56).

Neohibolites ewaldi (v. Strombeck, 1861)

Plate 43, figs. 1-5

- 1847 *Belemnites semicanaliculatus* Blainville; d'Orbigny, p. 23, pl. ix, figs. 7 and 8.
 *1861 *Belemnites Ewaldi* v. Strombeck, p. 34.
 1911a *Neohibolites Ewaldi* (v. Strombeck); Stolley, p. 31, pl. I, figs. 1-20.
 1911a *Neohibolites clava* Stolley, p. 37, pl. I, figs. 21-29; pl. II, figs. 1-12.
 1911a *Neohibolites inflexus* Stolley, p. 42, pl. I, fig. 30; pl. II, figs. 13-26.
 1955 *Neohibolites ewaldi* (v. Strombeck); Swinnerton, p. 64, pl. xvi, figs. 8-26; pl. xvii, figs. 1-14.

Type specimen. Lectotype (designated by Swinnerton 1955, p. 65), the original of d'Orbigny (1847, pl. ix, fig. 7), Aptian, southern France.

Material. Three rostra from bed 2 (235, 236, 238); nineteen rostra from bed 7 (185-203); nine rostra from beds 10-11 (208-217); and two rostra from bed 14 (223, 224). Upper Aptian, Rio Maputo section (Förster 1975, p. 24, fig. 6), southern Mozambique.

	<i>Dimensions</i>	L	X	Dvmax	Dlmax	<i>Groove Length</i>
208	50.8	17.5	7.0	7.7	8.4	
209	51.9*	—	7.9	8.3	8.7	
210	43.9	14.0	7.4	7.1	np	
211	34.8†	16.2	7.3	6.8	np	
185	50.6	23.7	7.2	7.5	np	
186	44.3†	23.4	7.3	7.3	np	
187	30.3	11.3	4.7	4.9	np	
188	35.6	—	7.1	7.5	np	
189	60.2	20.2	8.5	8.8	7.6	
190	49.4	18.3	7.5	7.7	np	
191	50.5	20.4	8.4	8.5	np	
192	44.4†	19.5	7.4	7.4	np	
193	40.0†	19.3	6.5	6.7	np	
196	35.3*	—	5.9	6.1	np	
235	46.0	16.9	7.1	7.1	np	

*: apex missing. †: alveolar region missing. np: groove not preserved.

Description. A group of medium sized, hastate to subhastate *Neohibolites*, with a total length approximately 6.5 times the maximum dorsoventral diameter (Dvmax). The outline and profile are similar and usually hastate or subhastate and symmetrical. Most are hastate, resembling *N. clava* Stolley and *N. inflexus* Stolley (see Stolley 1911a; Swinnerton 1936-1955), while the larger subhastate forms are closer to *N. ewaldi sensu stricto*. The apex of all these forms is moderately acute. Transverse sections are circular in the stem and apical regions, becoming compressed and subquadrate in the alveolar region.

A short, deep, well-defined alveolar groove is seen in some of the specimens, despite the destruction of the alveolar region. *Doppellinien* (double lateral lines) in these specimens are not clearly observed due to poor preservation. Decay of the alveolar region is common, and more hastate individuals superficially resemble the late Cretaceous genus *Actinocamax* Miller. Owing to the loss of the alveolus, no information is available concerning the phragmocone of this species. The apical line is central and ortholineate.

Remarks. Swinnerton (1936–56), p. 64) recognized that the species *N. clava* and *N. inflexus* described by Stolley (1911a) from the Aptian of Germany were in fact varieties of *N. ewaldi* (v. Strombeck), differentiated mainly by size and regularity of destruction of their alveolar regions (Stolley 1911b, p. 183). A similar range of variation in *N. ewaldi* was seen in single horizons (e.g. beds 7, 10–11) of the Rio Maputo section. Consequently, Swinnerton's interpretation is followed here in contrast to the continuous *N. ewaldi*–*N. clava*–*N. inflexus* lineage envisaged by Stolley (1911b) and Mutterlose *et al.* (1983). *N. ewaldi* differs from *N. minimus* (Miller) and its allied forms, which are smaller, less hastate with slightly flattened venters.

The specimens of *N. ewaldi* from southern Mozambique were previously referred to as *N. cf. inflexus* Stolley by Wachendorf (1967, p. 279) and Förster (1975, p. 25).

Family DIMITOBELIDAE Whitehouse, 1924

Genus PERATOBELUS Whitehouse, 1924

Type species. *Belemnites oxys* Tenison-Woods, 1884, by original designation.

Diagnosis. See Whitehouse (1924, p. 410), Stevens (1965, p. 61), Doyle (1985, p. 27, fig. 4, 1987a).

Peratobelus foersteri sp. nov.

Plate 43, figs. 6–12

Type specimens. Holotype, 229, bed 14. Paratypes, 204, bed 7; 219, 220, beds 10–11; 227, 228, bed 14. Upper Aptian, Rio Maputo section (Förster 1975, p. 24, fig. 6), southern Mozambique.

Other material. One rostrum from bed 2 (237); two rostra from bed 7 (205, 207); two rostra from beds 10–11, (221, 222); and five rostra from bed 14 (230–234). Upper Aptian, Rio Maputo section (Förster 1975, p. 24, fig. 6), southern Mozambique.

Derivation of name. In recognition of the work of Dr R. Förster.

Diagnosis. Small, conical *Peratobelus*. Outline symmetrical, conical, cylindrical to subhastate. Profile symmetrical, conical to cylindrical. Transverse sections subquadrate to pyriform. Ventrolateral alveolar grooves slightly sinuous.

	<i>Dimensions</i>	L	X	Dvl	Dlmax	<i>Groove Length</i>
204	27.6	10.5	3.6	4.1	17.3	
207	19.5*	7.7	3.9	4.0	np	
219	34.2	10.8	5.1	5.6	22.4	
220	29.3	—	—	—	20.7	
221	24.1	10.6	3.7	4.0	13.0	
227	31.1	9.3	4.5	4.9	21.7	
228	35.4	11.2	5.5	6.1	26.2	
229	33.9	11.1	4.5	5.1	23.8	
230	30.5	11.4	5.0	6.1	24.0	
231	26.7*	—	—	—	13.4	
232	22.7	7.9	4.2	4.5	12.5	
233	19.5*	9.8	3.6	4.3	7.6	
237	28.9	11.7	5.9	6.4	15.8	

*: apex missing. np: groove not preserved.

Description. Small, conical *Peratobelus*. Total length approximately 6 times the dorsoventral diameter at the position of the greatest lateral diameter (Dvl). The outline is symmetrical and generally cylindrical. While some forms are conical, most are cylindrical to subhastate with a slightly inflated stem region. The apex is acute, and often attenuate in juvenile specimens. The profile is symmetrical or almost symmetrical and usually conical or cylindrical, depending on the flatness of the venter. The stem region is not inflated in profile. Transverse sections are subquadrate to rounded subquadrate, roundness increasing adapically. The

venter is generally flattened, the stem and apical regions being slightly depressed in contrast to the slightly compressed alveolar region.

Two long, deep ventrolateral alveolar grooves run parallel to the venter for two thirds to three quarters of the length of the rostrum. Where the outline is inflated, the otherwise straight grooves may develop a 'kink'. Apically the grooves may be slightly dorsally deflected, but there is no evidence to suggest they are prolonged as lateral lines, seen in *Dimitobelus*. As in all *Peratobelus* species, lateral lines are poorly preserved, but some dorsolateral alveolar flattening is present. The alveolar region is preserved entire, with no development of a pseudalveolus. No phragmocones were present in any of the specimens, but the alveolus penetrates approximately one third of the rostrum.

Remarks. *P. foersteri* sp. nov. is typical of its genus. It is cylindrical with a normal alveolar region, a robust transverse section and extremely long ventrolateral alveolar grooves. In form it resembles the type species *P. oxys* (Tenison-Woods), but differs in its smaller size, its conical profile, and its less hastate outline. *P. bauhinianus* Skwarko also approaches *P. foersteri* sp. nov., but is distinguished by its more regular subhastate form (Skwarko 1966, p. 124, pl. 15, figs. 7-11). Finally, *P. foersteri* sp. nov. resembles *Tetrabelus willeyi* Doyle (Doyle 1987a) because of its conical form, but the latter is distinguished by its marked, ventrally curving alveolar grooves.

P. foersteri sp. nov. was previously referred to as *Peratobelus* sp. nov. by Wachendorf (1967, p. 279) and by Förster (1975, p. 25).

PALAEOBIOGEOGRAPHICAL IMPLICATIONS

The discovery of *Neohibolites* and *Peratobelus* in southern Mozambique is an important addition to our understanding of the distribution of these genera. Stevens (1963, 1965, 1973) and Doyle (1985, 1987b) have discussed the distribution of these belemnites in the Aptian and Albian. They suggested that at this time *Neohibolites* and the related genus *Parahibolites* migrated widely away from their Tethyan origins, penetrating deep into both hemispheres. Thus in the Aptian of the Southern Hemisphere, *N. minimus* and its allies are recorded from South America and Antarctica (Stevens 1965; Willey 1973) (text-fig. 1), and by the Albian/Cenomanian they are recorded in addition from Madagascar, southern India, and Japan (Stevens 1965). Doyle (1985) has suggested that *Neohibolites* was also present in Australia and New Guinea at this time. Forms related to *N. ewaldi* are known from South America in the Aptian (Liddle 1946; Stevens 1965), as shown in text-fig. 1. Both *N. minimus* and *N. ewaldi* are extremely common in the Aptian and Albian of the Northern Hemisphere, and are especially well known in north-west Germany and England (Stolley 1911a, b; Swinnerton 1936-1955; Spaeth 1971).

By contrast, *Peratobelus* and the Dimitobelidae had a much more restricted distribution, being found only within the 30 °S Cretaceous palaeolatitude (Stevens 1973; Doyle 1985, 1987b; see text-fig. 1). The Aptian genus *Peratobelus* was previously thought to have been restricted to the Pacific coast of Gondwana, similar to *Dimitobelus* in the Albian, and in contrast to the trans-Gondwanian *Tetrabelus* (Doyle 1987b). The discovery of *Peratobelus* in southern Mozambique, still within the 30 °S palaeolatitude (see Smith *et al.* 1981, p. 34) (text-fig. 1) indicates a wider distribution than its successors *Dimitobelus* and *Tetrabelus*, occurring on the Pacific and Tethyan coasts of

EXPLANATION OF PLATE 43

Figs. 1-5. *Neohibolites ewaldi* (v. Strombeck), ventral outlines and right profiles, ×1. Aptian, Rio Maputo, southern Mozambique. 1, large individual without apex, 209. 2, large individual with ?postmortal borings, 189. 3, hastate individual, 191. 4, 208. 5, 185.

Figs. 6-12. *Peratobelus foersteri* sp. nov., ventral outlines and right profiles, ×1. Aptian, Rio Maputo, southern Mozambique. 6, holotype, 229. 7, paratype, robust individual, 228. 8, paratype, 219. 9, paratype, 227. 10, paratype, squat individual with flat venter, 220. 11, paratype, juvenile, 204. 12, hastate individual, 230.



1



2



3



4



5



6



7



8



9



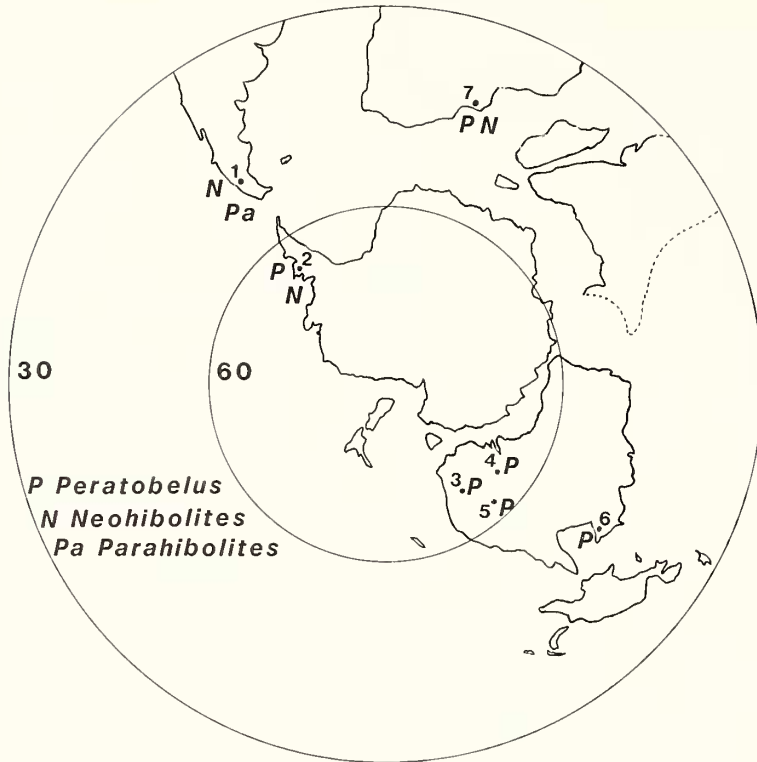
10



11



12



TEXT-FIG. 1. Palaeogeographic reconstruction of southern Gondwana in the Aptian. Numbered localities are as follows: 1, Patagonia; 2, Alexander Island, Antarctica; 3, New South Wales, Australia; 4, South Australia; 5, Queensland, Australia; 6, Northern Territories, Australia; 7, southern Mozambique.

Gondwana in the Antarctic Peninsula, Australia, and southern Africa. The discovery of *Neohibolites* in association with *Peratobelus* in Mozambique is similar to the occurrence of *Parahibolites* with *Tetrabelus* in the Antarctic Peninsula and India (Doyle 1985), and strengthens the hypothesis of a widespread *Neohibolites*/*Parahibolites* migration in the Aptian and Albian.

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